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Browning et al.

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(45) **Date of Patent: Apr. 19, 2016**

(54) **PAVING STONES**

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E01C 5/06 (2006.01)

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CPC ***E01C 5/06*** (2013.01); *E01C 2201/02* (2013.01)

(58) **Field of Classification Search**
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USPC 404/34, 37, 41, 42
See application file for complete search history.

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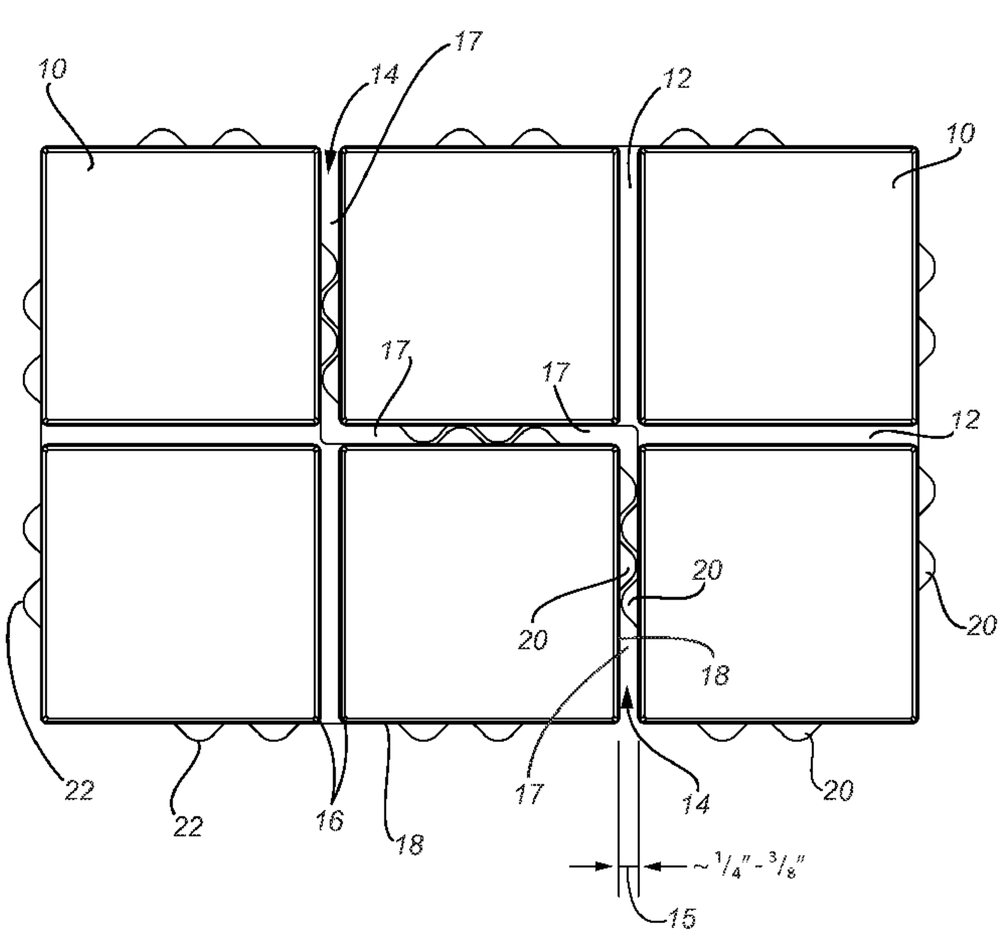
(57) **ABSTRACT**

Generally L-shaped, square, rectangular, triangular, hexagonal, parallelogram and other-shaped paving stones with interfitting vertical spacers forming serpentine side contact surfaces that provide enhanced stone-to-stone interlocking in both water-permeable and water-impermeable paving installations.

20 Claims, 10 Drawing Sheets



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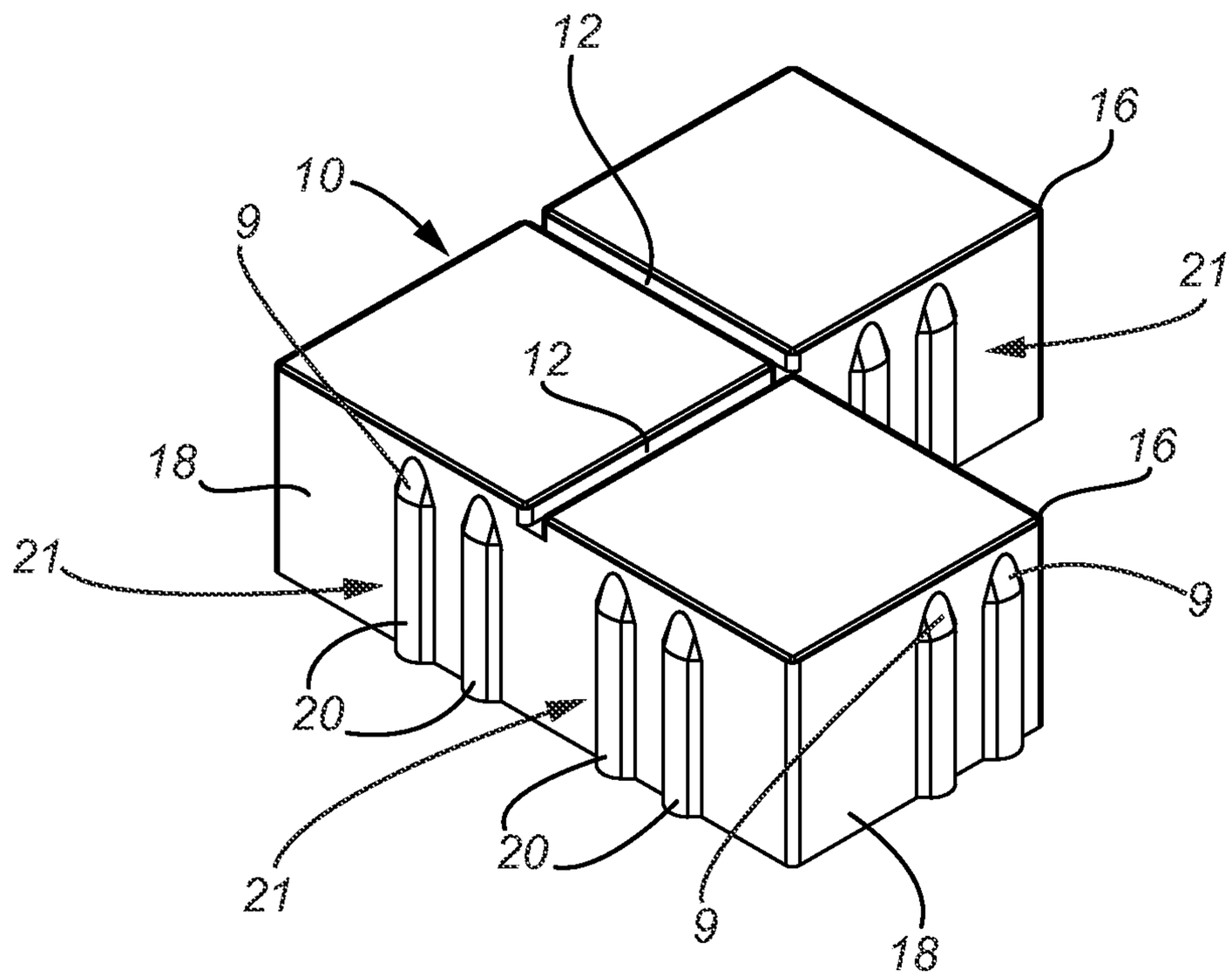

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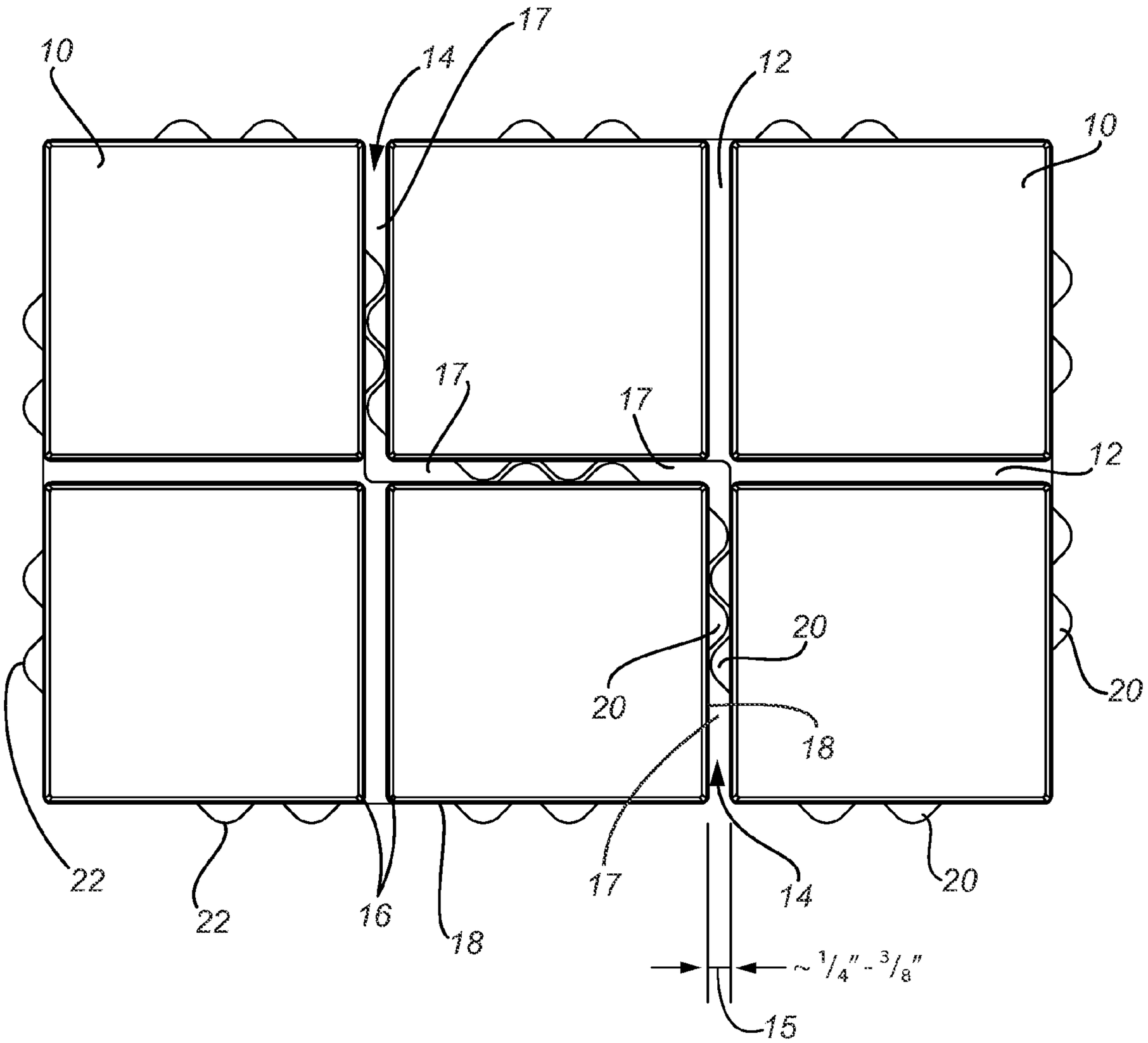
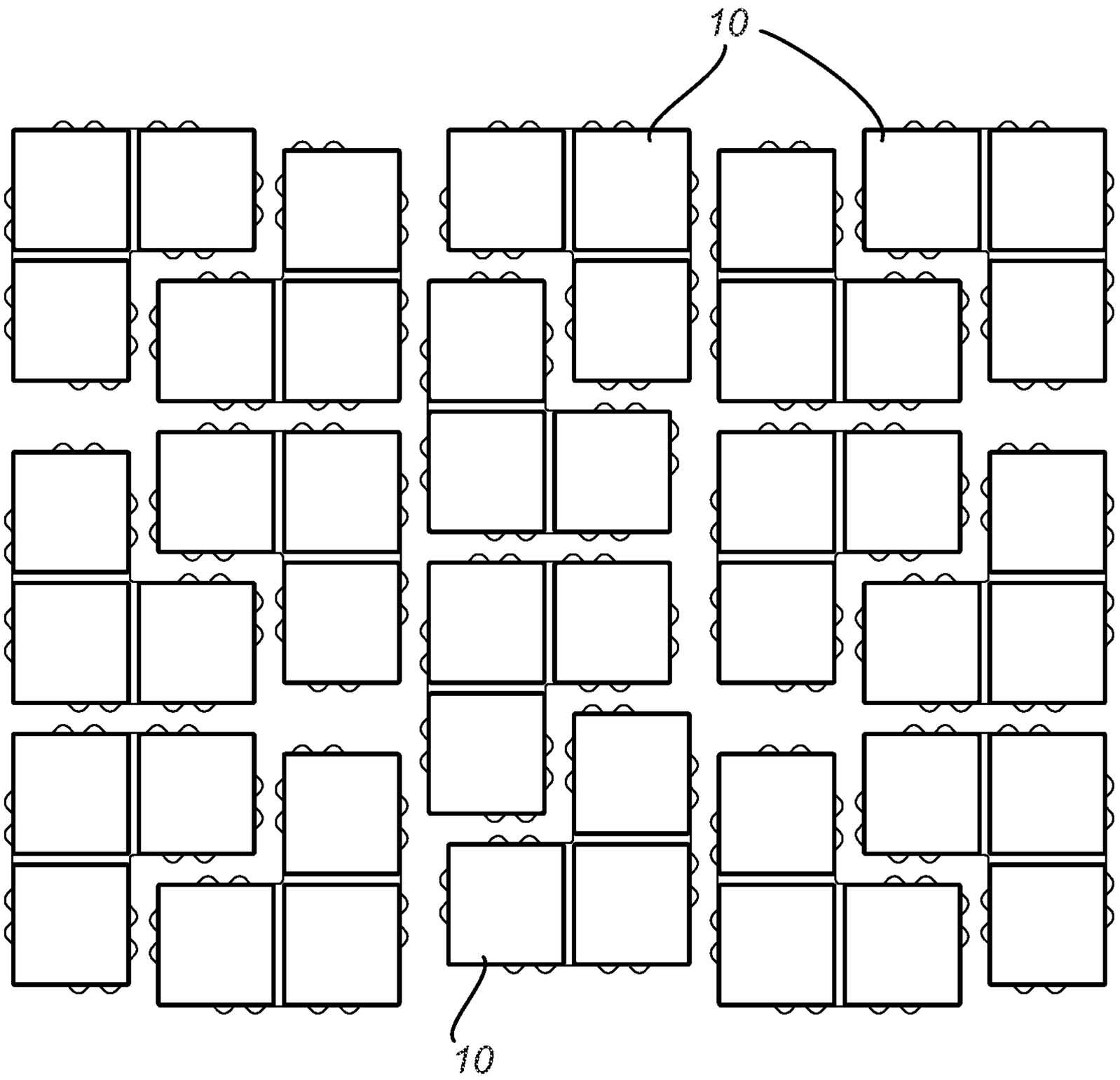


Fig. 2



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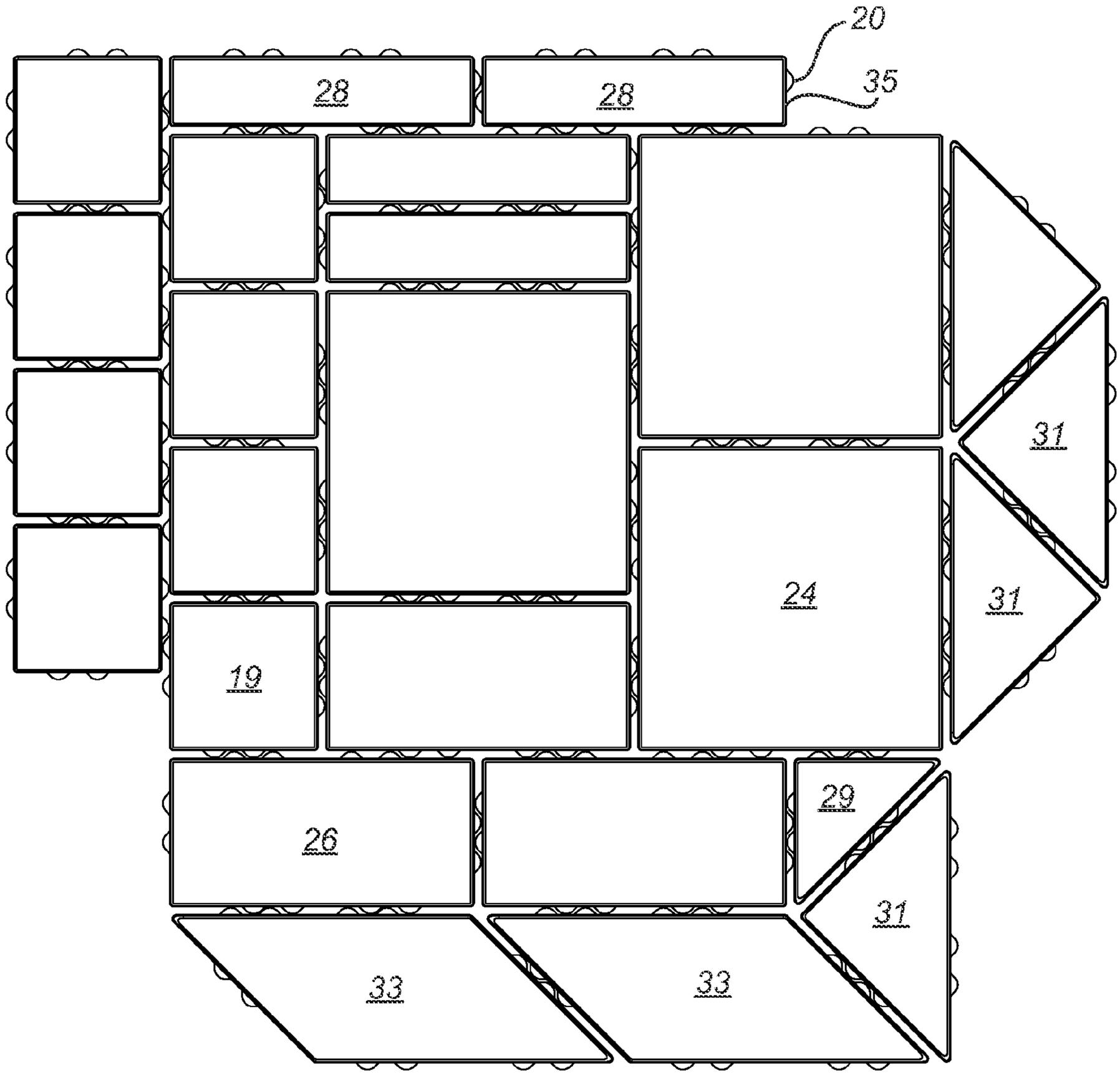

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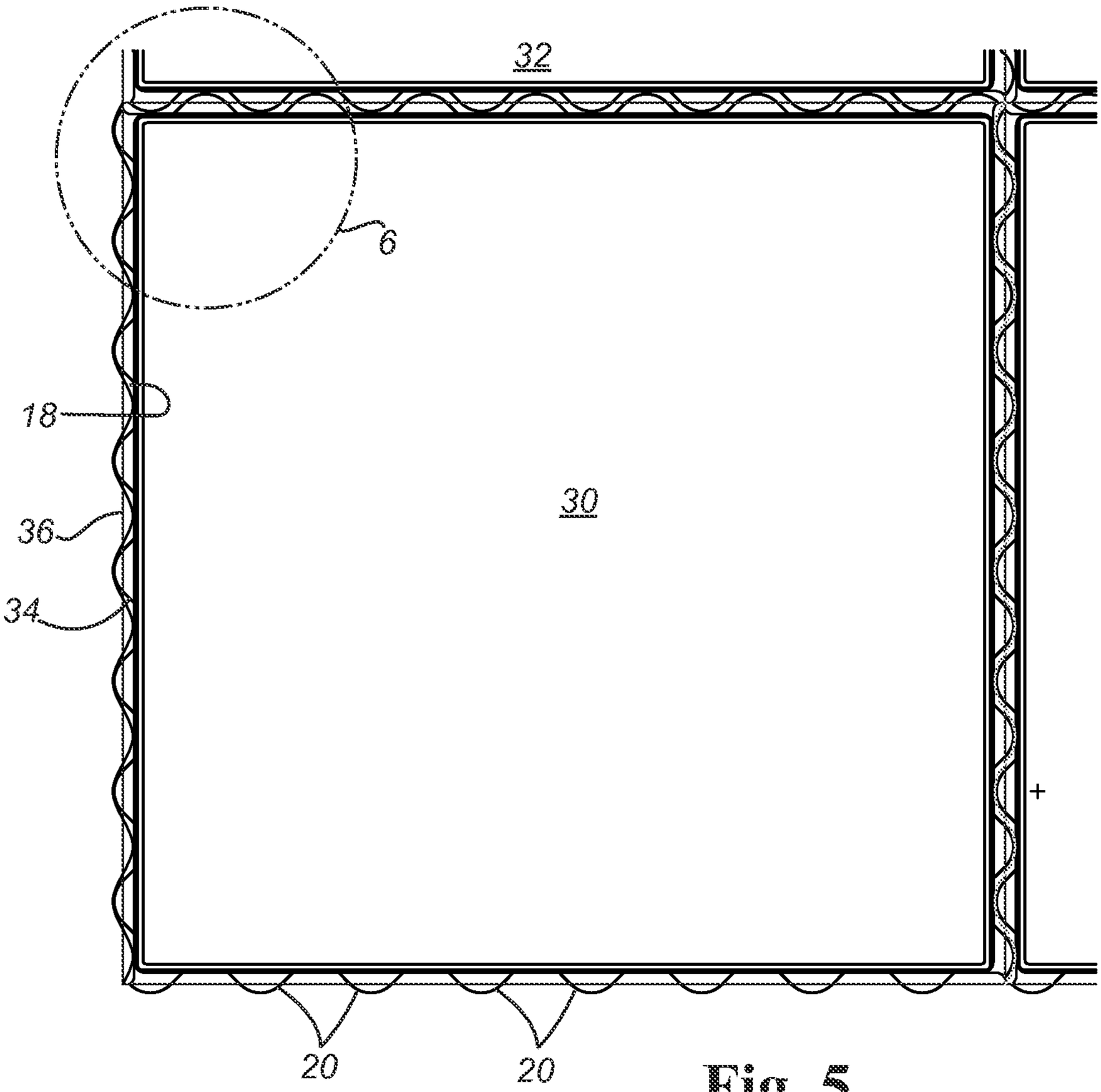
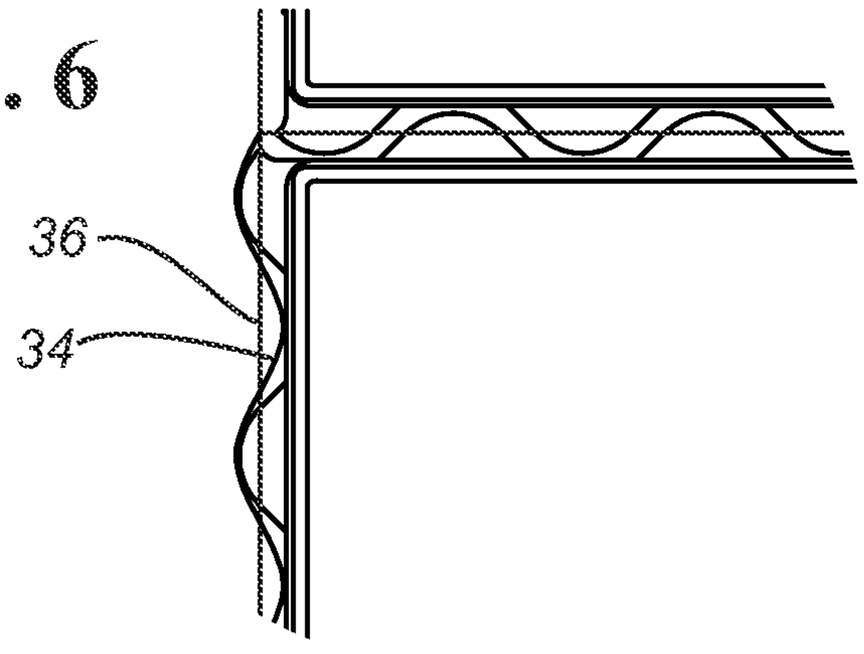


Fig. 5

Fig. 6



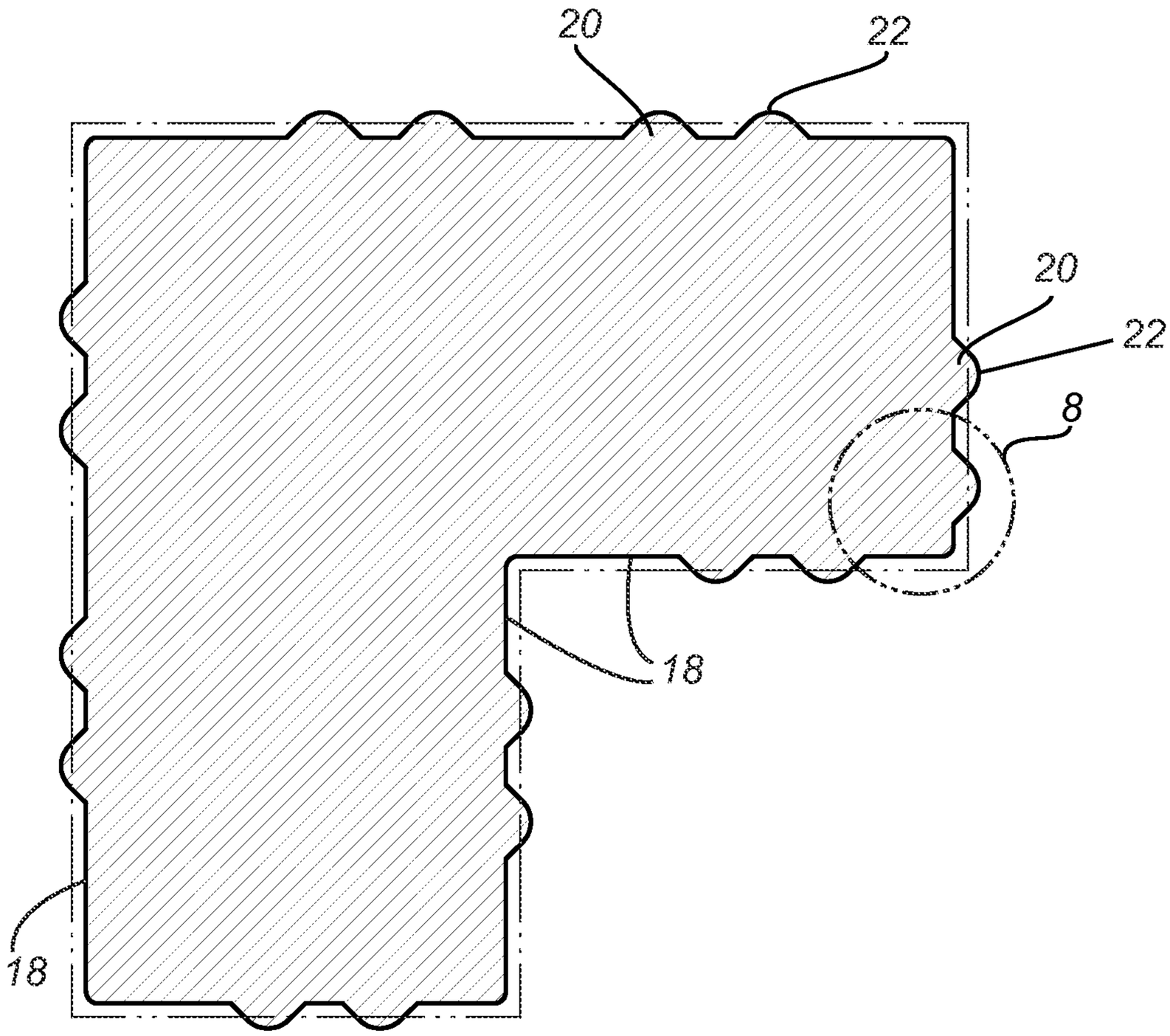

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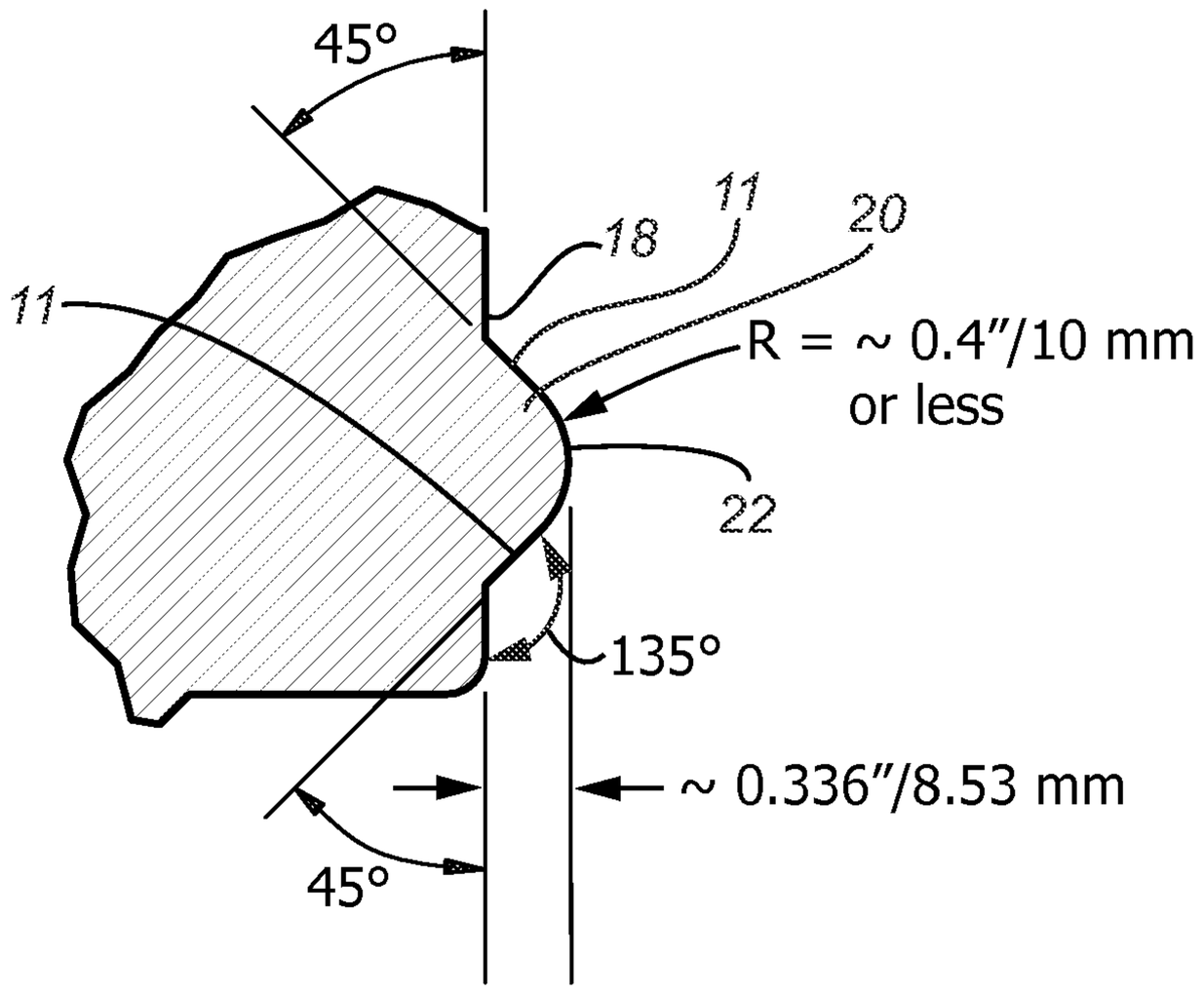
Fig. 7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18
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20
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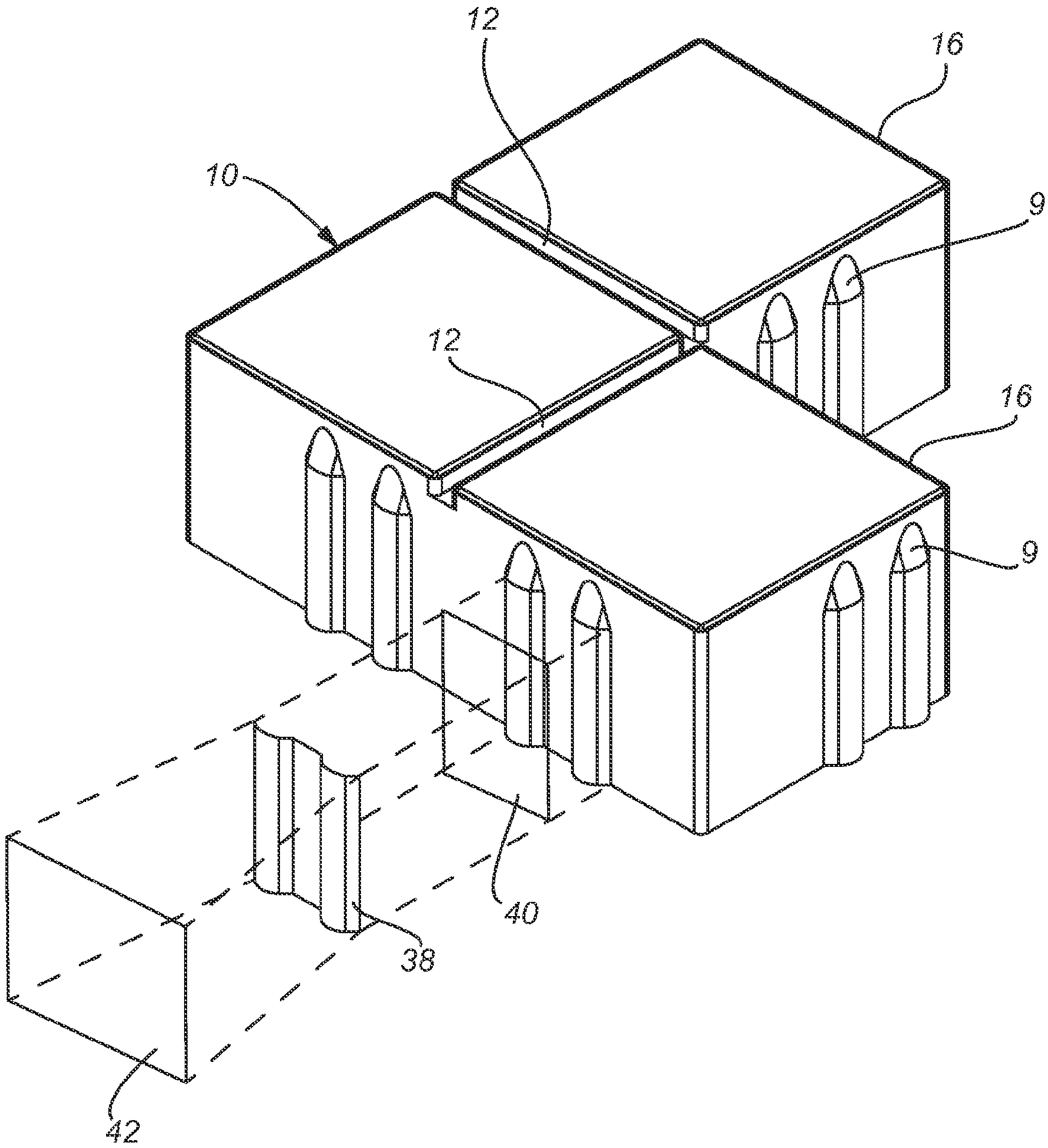
or less
22
135°
~ 0.336”/8.53 mm
45°

Fig. 8



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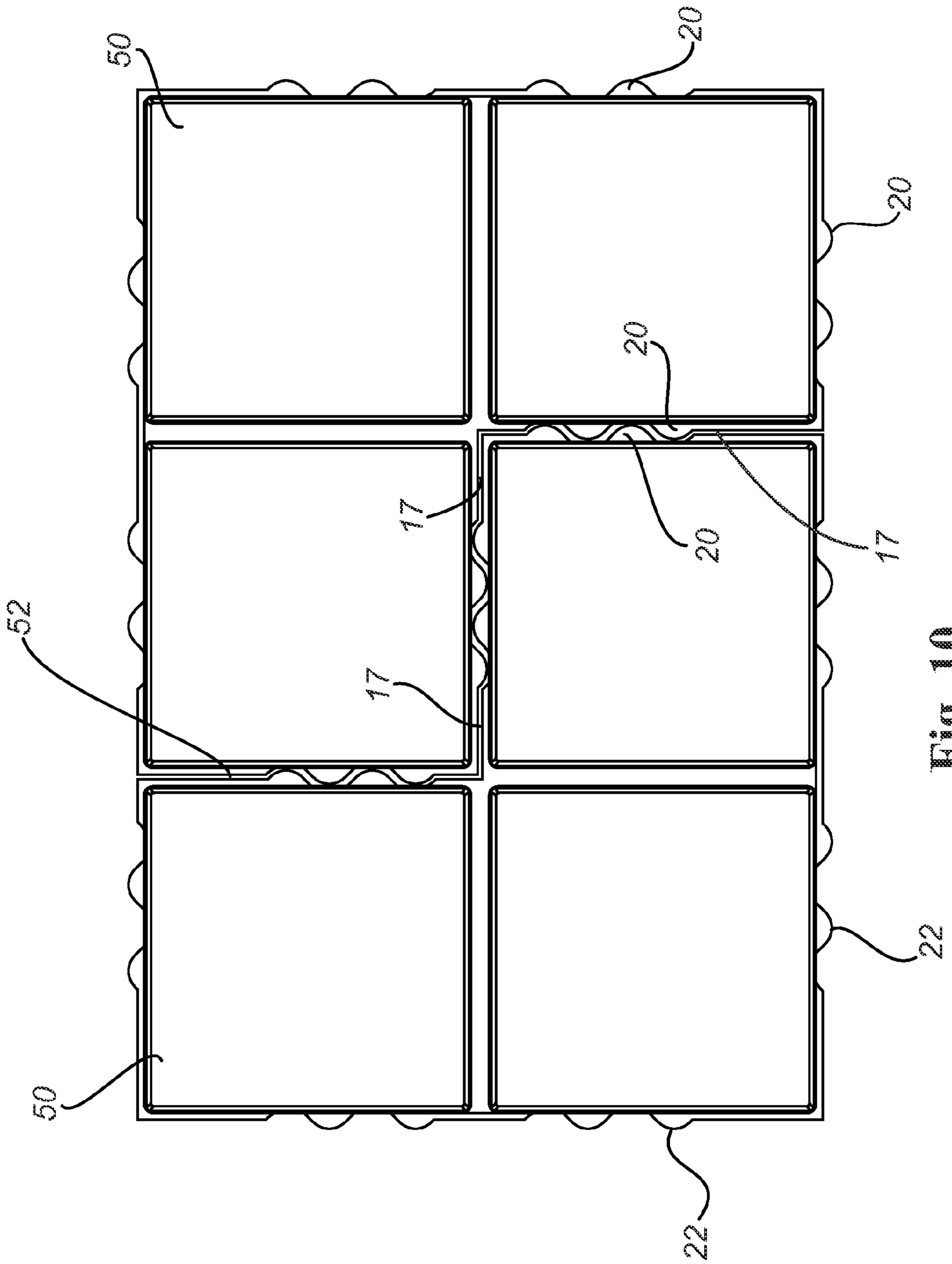

Fig. 10

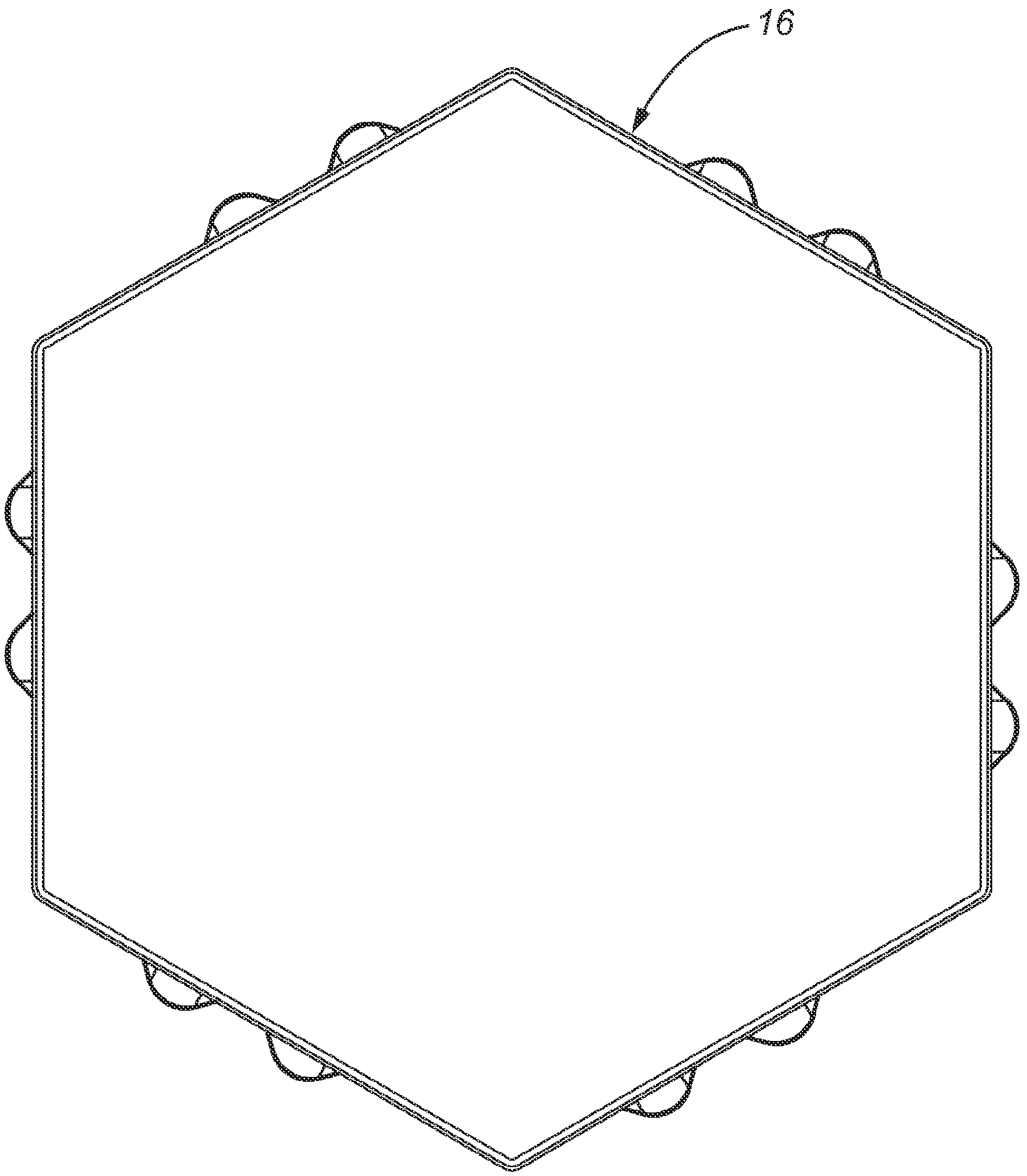

Fig. 11

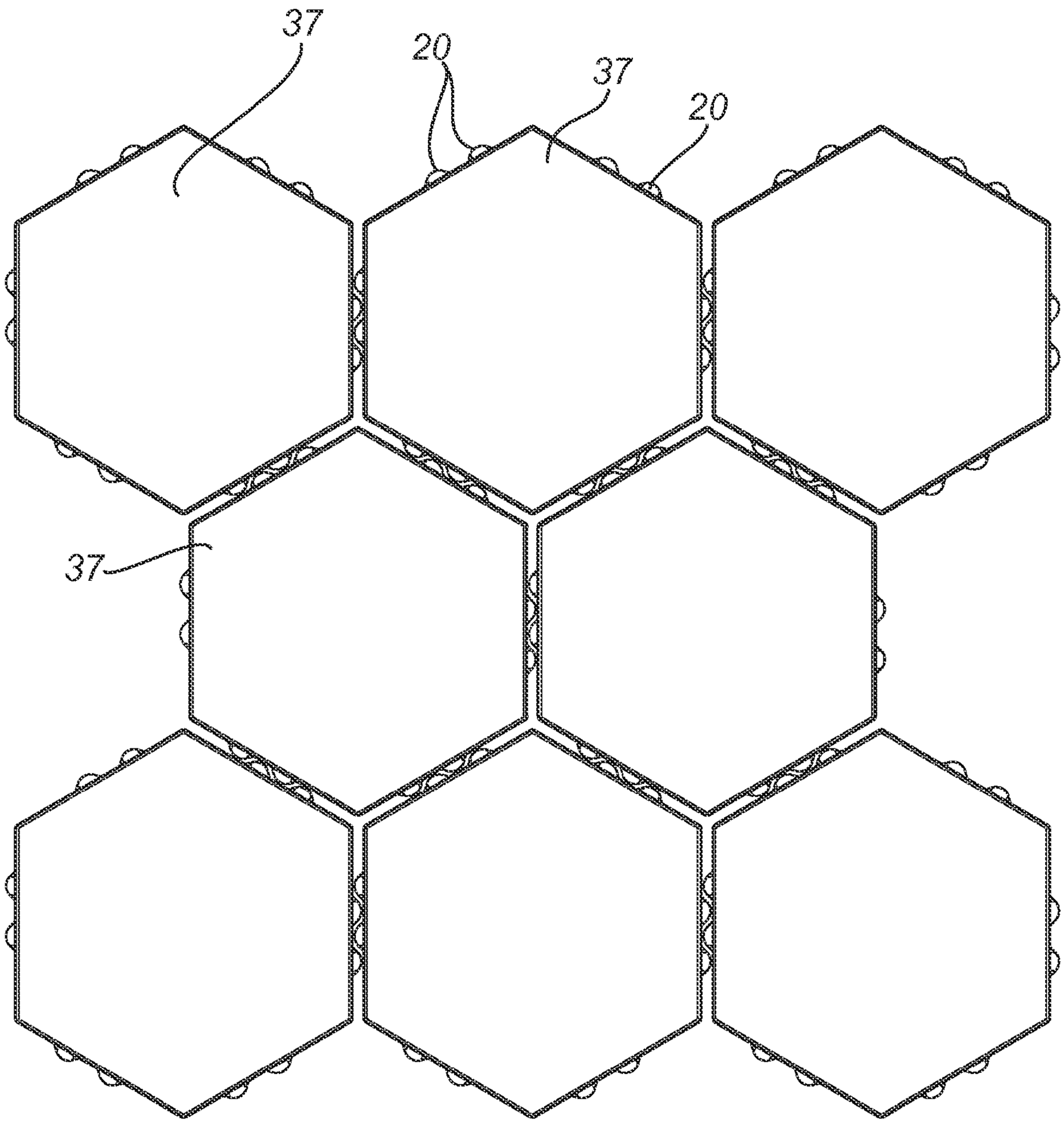

Fig. 12

PAVING STONES

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application Ser. No. 61/716,033 for "Paving Stones" filed Oct. 19, 2012, Len Browning and Robert J. Lundell, inventors, which is incorporated in this application in its entirety by this reference.

FIELD OF THE INVENTION

This invention relates to paving stones and blocks, natural and manmade.

BACKGROUND

Paving stones have been in use for thousands of years. Initially such stones were literally that, naturally occurring stones or rocks of various shapes and compositions. Even the earliest installers of such stones recognized that stones of regular shapes and sizes facilitated their installation and effectiveness in use. That doubtless led initially to care in selecting stones and placing them and later to preparatory shaping of stones to facilitate their installation and function. Eventually such regular shapes came to be embodied in manmade bricks and "stones," including a variety of different shapes and compositions.

Notwithstanding thousands of years of human experience in paving a variety of different surfaces for a variety of different reasons and uses, the need continues for pavers that can better address certain requirements.

Among those requirements are the need to successfully transfer the load of vehicles that use the paving to the subgrade without damaging the base course or its stability.

As is explained by the ICPI Tech SPEC Number 1 (Glossary of Terms for Segmental Concrete Pavement), interlocking concrete pavement is a system of paving that consists of discrete, hand-sized paving units with either rectangular or dentated shapes manufactured from concrete. The units are placed in an interlocking pattern, compacted into coarse bedding sand, the joints filled with sand and compacted again to start interlock.

Interlocking results when frictional forces between paving units prevent them from rotating, or moving horizontally or vertically in relation to each other. Interlocking is also defined as the inability of a concrete paver to move independently of its neighbors. Friction forces enable load transfer among the paving units. There are three kinds of load transfer, vertical interlock, horizontal interlock and rotational interlock. Vertical interlock is achieved by shear transfer of loads to surrounding units through sand in the joints. Horizontal interlock is primarily achieved through the use of laying patterns that disperse forced from braking and accelerating vehicles. Rotational interlock is achieved by using pavers of sufficient thickness, placed closely together, and restraining them by a stationary edge such as a curb.

Interlocking is not, however, the only characteristic of concern. Many paver installations need to accommodate the flow of water through the paved surface and into underlying structures, installations of which pavers are sometimes referred to as permeable interlocking concrete pavement.

Likewise, it is important the pavers be attractive, easy to install manually or with mechanical systems, and that they be easy to manufacture economically, quickly and reliably without undue complexity in the manufacturing equipment and without undue difficulty associated with wear of the manufacturing equipment.

SUMMARY

The terms "invention," "the invention," "this invention" and "the present invention" used in this patent are intended to refer broadly to all of the subject matter of this patent and the patent claims below. Statements containing these terms should be understood not to limit the subject matter described herein or to limit the meaning or scope of the patent claims below. Embodiments of the invention covered by this patent are defined by the claims below, not this summary. This summary is a high-level overview of various aspects of the invention and introduces some of the concepts that are further described in the Detailed Description section below. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in isolation to determine the scope of the claimed subject matter. The subject matter should be understood by reference to appropriate portions of the entire specification of this patent, any or all drawings and each claim.

The pavers of this invention are attractive, easy and inexpensive to manufacture and install and can be assembled into strong paver systems that achieve good vertical, horizontal and rotational interlocking, balanced with substantial permeability to allow water to drain through such systems into underlying structures.

Pavers of this invention may be made in a number of different shapes, usually generally (a) square, (b) rectangular, (c) triangular, or (d) that can be thought of as combinations of squares, rectangles and triangles (such as L-shaped and parallelogram-shaped stones). The pavers of this invention may also be made in other shapes such as hexagons.

Significantly, the vertical walls of these pavers include "serpentine," "sinuous," "wavy," "saw tooth," "sinusoidal" or "crenelated" portions (when viewed in plan or "from above") that are positioned to inter-fit with like-shaped portions of other pavers of this system in assemblies of pavers. (The term "serpentine" will generally be used in this patent to mean all of the above and other appropriate terms for wall portions of the general shapes described and depicted herein).

These serpentine wall portions contact abutting paver wall portions to maintain desired separation between pavers to permit vertical water flow when desired. Moreover, the serpentine wall portions providing superior frictional vertical interlocking, as well very effective horizontal and rotational interlocking between pavers. These serpentine wall portions are easier to produce and more durable than more angular side wall shapes. Superior frictional interlocking enables pavers of particular geometries and dimensions to accommodate more water flow because there is relatively more room for vertical water flow channels.

While serpentine wall portions can be used with numerous other paver shapes such as hexagons, among others, they are well-adapted for use with pavers that are rectangles, including squares, or combinations of rectangles, such as L-shaped pavers, triangles, parallelograms and combinations of triangles and rectangles.

BRIEF DESCRIPTION OF THE DRAWINGS

Illustrative embodiments of the present invention are described in detail below with reference to the following drawing figures:

FIG. **1** is an isometric view of a generally L-shaped embodiment of a paving stone of the this invention.

FIG. **2** is a top plan view of two abutting L-shaped stones like the one shown in FIG. **1**.

FIG. **3** is a top plan view of one embodiment of a mold pallet layout of L-shaped stones like those shown in FIG. **1**.

FIG. **4** is a top plan view of an arrangement of several different paving stone embodiments of this invention.

FIG. **5** is a model of a paving stone edge shape illustrating the length of contacting faces with an exemplary serpentine block edge shape.

FIG. **6** is an enlarged fragment of FIG. **5** taken at circle "**6**."

FIG. **7** is a horizontal cross section of the stone of FIG. **1**.

FIG. **8** is an enlarged fragment of FIG. **7** taken at circle "**8**."

FIG. **9** is a view similar to FIG. **1** with a "sinuous" or "serpentine" portion of the paver wall projected and flattened to show its greater effective contact area.

FIG. **10** depicts an alternative embodiment of the pavers of this invention with abutting walls for substantially water impermeable paving installations.

FIG. **11** depicts a top plan view of hexagonal paving stone of this invention.

FIG. **12** is a top plan view of an assembly of hexagonal stone like the stone of FIG. **11**.

DETAILED DESCRIPTION

The subject matter of embodiments of the present invention is described here with specificity to meet statutory requirements, but this description is not necessarily intended to limit the scope of the claims. The claimed subject matter may be embodied in other ways, may include different elements or steps, and may be used in conjunction with other existing or future technologies. This description should not be interpreted as implying any particular order or arrangement among or between various steps or elements except when the order of individual steps or arrangement of elements is explicitly described.

FIGS. **1** and **2** depict an L-shaped paving stone **10** having false joints **12** that look like the full joints **14** visible in FIG. **2** to create an installed pattern appearing to be made of square pavers **16**. Each stone **10** has side walls **18** and spacers **20** with curved cross-section crowns **22**. Spacers **20** serve at least two purposes. First, they separate stones **10** in a pavement installation so that (a) there are vertical channels **17** between stones **10** that can "filled" with clean, open graded fine aggregate and through which water can flow and (b) stones **10** will be uniformly spaced and aligned in paving installations. Second, the spacers provide interlocking contact surfaces **21** between tiles that interlock the stones **10** vertically, horizontally and rotationally.

As may be appreciated by reference to FIG. **2**, arrangements of L-shaped stones **10** with the square paver units **16** oriented in rows and columns will result in inter-fitting of spacers **20** with the crown or furthest protruding portion **22** of spacers **20** on one stone **10** in contact with the side walls **18** of an adjacent stone **10**.

FIG. **8** provides an enlarged fragment showing an exemplary spacer **20** geometry and dimensions, but other geometries and dimensions are also possible. The tops **9** of spacers **20** can be square to the spacer **20** and paver walls **18**, but a sloping transition as depicted in the drawings typically is easier to manufacture and more durable in transportation, placement and use. In embodiments of this invention depicted in the drawings, (apart from the spacer top or transition **9**) each spacer has two planer surfaces joined to each other by a curved or crown surface **22**. Utilizing the geometry and

dimensions depicted in the figures for spacers **20** (with spacers **20** projecting or protruding from walls **18** about one-third inch (specifically, for instance, projecting 0.336 inches (8.53 mm)) will provide spacing (**15** on FIG. **2**) of approximately ¼ to ⅜ inch between opposed walls **18** in assemblies of L-shaped blocks **10**.

Use of spacer **20** walls **11** at an inside angle relative to the plane of wall **18** of approximately 45 degrees and, therefore, at an outside angle relative to the plane of wall **18** of approximately 135 degrees (so that the two spacer walls **11** of each spacer **20** are separated by approximately 90 degrees from each other) is beneficial and therefore desirable. For instance, use of the curved crown **22** and the planar wall angles described here makes the spacers easy to form and durable in manufacture, shipment, placement and use. However, other angles could also be used, and other shorter or longer radii than the radius of approximately 0.4 inches or less (about 10 mm or less) shown in FIG. **8** could be used.

As may be appreciated by reference to FIG. **7**, the locations of spacers **20** on opposite walls of L-shaped pavers **10** are offset from each other by one-half of the distance between adjacent spacers **20** on each paver **10**. This facilitates the inner-fitting of spacers **20** on abutting pavers **10** (illustrated in FIGS. **2**, **4** and **9**). The illustrated arrangement of pairs of spacers **18** result in automatic inter-fitting of spacers in substantially all practical arrangements of L-shaped blocks **10**.

Alternative sizes and shapes of pavers are shown in FIG. **4**, which includes small square pavers **22**, large square pavers **24**, large rectangular pavers **26**, small rectangular pavers **28**, small triangular pavers **29**, large triangular pavers **31** and parallelogram pavers **33**. Hexagonal pavers **37** are shown in FIGS. **11** and **12**. As is depicted in FIGS. **4** and **12**, the narrow rectangular pavers **28** have room for only one spacer **20** one each paver **28** end **35** using spacers **20** of the size and locations depicted in the drawings. As is clear from the Figures, particularly including FIG. **4**, this invention may be embodied in pavers having a number of different general shapes. For simplicity only, however, much of the description herein focuses on and describes an exemplary L-shaped paver **10**. The embodiments of the present invention and the following patent claims should not be understood to be limited to L-shaped pavers or any other particular paver shape unless a description or claim explicitly contains such a limitation.

As mentioned above, vertical interlocking between paving stones is achieved by shear transfer of loads to surrounding units. This occurs as a result of contact between the sides of pavers and through coarse sand or other aggregated in the joints between the opposed sides of closely spaced pavers. Some horizontal interlocking occurs for the same reason, but the laying pattern of pavers and interlocking between pavers also contribute to horizontal interlocking.

The "serpentine," "sinuous," "wavy," "saw tooth," "sinusoidal" or "crenelated" portions of the side walls of the pavers of this invention provide enhanced vertical interlocking because they increase and optimize the surface areas of abutting pavers that are in contact with each other (directly or through coarse sand or other aggregate in the joints). Simply stated, more surface contact (for a given side wall portion), better resists relative vertical movement between adjacent stones, and this results is greater vertical interlocking. The surface interface between abutting pavers **10** of this invention is not a plane (as would be the case with flat walls) but is an undulating or wavy surface.

Horizontal interlocking occurs as a result of similar contact between the sides of pavers and through coarse sand or other aggregate in the joints between the opposed sides of closely spaced pavers. Significantly, horizontal interlocking also

occurs in the interlocking structure of the side walls **18**. Force applied horizontally tending to cause relative horizontal movement between abutting stones is resisted by friction and by the protruding ridges **20** that transfer force from the ridges **20** on one paver **10** to the ridges **20** on an abutting paver **10**.

FIGS. **5** and **6** facilitate description of these reasons that enhanced interlocking may be achieved in embodiments of this invention. FIG. **5** depicts a hypothetical square paver **30** that has spacers **20** that are shown (on the top and right sides) inter-fitted with other spacers **20** on a second square paver **32**. The "contact path" **34** (that is, an "edge view" of a contact surface between pavers) is illustrated, together with a hypothetical "straight line" contact path **36**. As can be easily seen by comparison of these lines **34** and **36**, the serpentine path is longer. For a 12 inch square paver **30** with the spacer **20** shape and geometry illustrated in the figures and described above, the serpentine path has been calculated to be 8.62% longer than the straight line path **36**, which means an 8.62% larger contact surface. Such a larger, sinusoidal, wavy or undulating contact surface **38** is depicted in FIG. **9** as if separated from the stone **10** and is compared to a flat surface **40** occupying the same portion of the stone **10** wall **18** as the undulating surface **38**. If undulating surface **38** is "flattened," it is the same height but is wider and therefore a larger surface **42**. Thus the vertically-extending straight, horizontally-extending serpentine contact surface contact surface **38** provides a greater contact area for a given width of paver **10** wall **18**. This reduction in the portion of the side that needs to be used in interlocking permits a larger area where the facing walls **18** are separated. At the same time it provides enhanced interlocking, a vertically-extending straight, horizontally-extending serpentine surface shape permits and facilitates formation of the pavers **10** using conventional paver-making equipment and likewise facilitates relative vertical movement of pavers **10** in placement or removal of the pavers.

As a consequence of the capacity for achieving acceptably significant interlocking utilizing the serpentine shapes described above, greater portions of a particular side wall **18** can be straight and separated from the opposing side wall **18** of an adjacent block, thereby providing greater areas **17** (see FIG. **2**) and greater capacity for flow of water down between the opposed side walls **18** and into underlining structure in a paving system designed to permit water infiltration.

If embodiments of the pavers **10**, **19**, **24**, **26**, **28**, **29**, **31**, **33** and **37** of this invention are to be used in installations where water infiltration is not needed, as is illustrated in FIG. **10**, opposed portions of the walls **17** of pavers **50** can abut at **52** (with space for coarse concrete sand), thereby enhancing frictional interlocking of the pavers because of the greater wall contact. Additional spacers **20** could also be used to further enhance interlocking since areas with wide gaps for water infiltration are not needed.

The design of the spacer **20** of this invention permits the produced products to grow slightly in size as a result of wear of the manufacturing molds and, in effect, adjust to the enlarged units without creating interferences because the interfacing block shapes are forgiving and can be simply scaled up or down without changing block to block relationships.

In addition to increased frictional area between abutting pavers as a result of the serpentine frictional area, the projecting spacers resist relative motion of pavers horizontally because the projecting spacers **20** act as "stops" resisting such relative movement.

Different arrangements of the components depicted in the drawings or described above, as well as components and steps not shown or described are possible. Similarly, some features and subcombinations are useful and may be employed without reference to other features and subcombinations. Embodiments of the invention have been described for illustrative and not restrictive purposes, and alternative embodiments will become apparent to readers of this patent. Accordingly, the present invention is not limited to the embodiments described above or depicted in the drawings, and various embodiments and modifications can be made without departing from the scope of the claims below.

That which is claimed is:

1. An assembly of dry-cast concrete pavers arranged on a permeable substrate,

wherein each paver comprises:

a. generally planer, generally parallel top and bottom surfaces,

b. generally planer vertical walls perpendicular to the top and bottom surfaces, and

c. a pair of vertically extending spacers protruding from at least one vertical wall, wherein each spacer comprises:

i. two planer surfaces arranged at approximately 90 degrees to each other and arranged at an outside angle of approximately 135 degrees relative to the vertical wall,

ii. wherein the two planer surfaces form a triangular portion that protrudes from the vertical wall, wherein the triangular portion comprises a rounded point having a radius of 10 mm or less,

iii. wherein a distance from the vertical wall to the rounded point is approximately 8.5 mm,

wherein at least two pavers are arranged in an abutting relationship so that the pair of spacers protruding from the vertical wall of the first paver inter-fit with the pair of spacers protruding from the vertical wall of the second paver,

wherein adjacent planer surfaces of the inter-fit spacers are in frictional contact with each other to vertically, horizontally, and rotationally interlock the abutting pavers.

2. The assembly of claim **1**, wherein a combined length of the two planer surfaces and the rounded point of each spacer is at least 8% greater than a length of a base of the triangular portion that extends between the two planer surfaces adjacent the vertical wall.

3. The assembly of claim **1**, wherein the rounded point of each spacer is in contact with the vertical wall of the abutting paver.

4. The assembly of claim **1**, wherein the spacers separate the opposed vertical walls of the abutting pavers by approximately ¼ inch to ⅜ inch.

5. The assembly of claim **4**, wherein gaps between the opposed vertical walls of the abutting pavers contain clean, open graded fine aggregate.

6. The assembly of claim **1**, wherein a plurality of the pavers are generally L-shaped in plan.

7. The assembly of claim **1**, wherein a plurality of the pavers are generally square in plan.

8. The assembly of claim **1**, wherein a plurality of the pavers are generally rectangular in plan.

9. The assembly of claim **1**, wherein a plurality of the pavers are generally triangular in plan.

10. The assembly of claim **1**, wherein a plurality of the pavers are generally parallelogram-shaped in plan.

11. An assembly of dry-cast concrete pavers arranged on a permeable substrate,

wherein each paver comprises:

a generally polygonal body;

a pair of generally congruent first and second walls extending radially from a first vertex of the polygonal body and being rotationally spaced from each other by an interior angle greater than 180° so that the first vertex is concave; and

a pair of vertically extending spacers protruding from the first wall and the second wall, wherein each spacer comprises:

two planer surfaces arranged at approximately 90 degrees to each other and arranged at an outside angle of approximately 135 degrees relative to the vertical wall,

wherein the two planer surfaces form a triangular portion that protrudes from the vertical wall, wherein the triangular portion comprises a rounded point having a radius of 10 mm or less,

wherein at least two pavers are arranged in an abutting relationship so that the pair of spacers protruding from the first wall of the first paver inter-fit with the pair of spacers protruding from the first wall of the second paver,

wherein adjacent planer surfaces of the inter-fit spacers are in frictional contact with each other to vertically, horizontally, and rotationally interlock the abutting pavers.

12. The assembly of claim **11**, wherein a distance from each wall to the rounded point of each spacer is the same.

13. The assembly of claim **11**, wherein a distance from each wall to the rounded point of each spacer is approximately 8.5 mm.

14. The assembly of claim **11**, wherein a combined length of the two planer surfaces and the rounded point of each spacer is at least 8% greater than a length of a base of the triangular portion that extends between the two planer surfaces adjacent each wall.

15. The assembly of claim **11**, wherein the rounded point of each spacer is in contact with the opposing wall of the abutting paver.

16. The assembly of claim **11**, wherein the spacers separate the opposed walls of the abutting pavers by approximately ¼ inch to ⅜ inch.

17. The assembly of claim **16**, wherein gaps between the opposed walls of the abutting pavers contain clean, open graded fine aggregate.

18. The assembly of claim **11**, wherein the polygonal body is generally L-shaped.

19. The assembly of claim **11**, wherein the polygonal body is a combination of rectangles.

20. The assembly of claim **11**, wherein the polygonal body is a combination of shapes from the group consisting of rectangles, triangles, parallelograms.

* * * * *